Chapter 4

Technology for Capacity Improvement

There are many technological initiatives underway that offer significant promise to improve the capacity of an airport, its surrounding terminal airspace, and the en route airspace. Even when considered individually, these technologies are significant steps in the right direction. However, the impact of each initiative will be enhanced by the integrated approach to capacity improvement that is being maintained through effective coordination of the various programs. At an overall level, this integration will be accomplished through the activities of the National Simulation Laboratory described in Section 4.3.1.

Section 4.1 covers technologies applicable to airport operations and the adjacent terminal airspace. These include the Precision Runway Monitor and the Converging Runway Display Aid that directly support the approach procedure improvements described in Section 3.1. Section 4.2 discusses technologies applicable to the en route airspace, including oceanic airspace. Section 4.3 covers technologies and programs that support planning and integration of the above programs, as well as technologies that will make changes and improvements to the National Airspace System easier and more efficient to implement.

Complete project details, including funding and implementation dates, where appropriate, are given in Appendix F. The projects described there include the key projects discussed in this section plus a large number of other projects that have an impact on capacity, although their primary focus might be different.

4.1 Airport and Terminal Airspace Capacity Technology

There are a number of programs that will improve the capacity of an airport and its surrounding terminal airspace. The Airport Surface Traffic Automation System will provide automation that will make ground operations safer and more efficient. The Precision Runway Monitor and the Converging Runway Display Aid have been discussed in Chapter 3 in connection with procedures for improved landing capacities at airports with multiple runways. The Microwave Landing System will make precision approach procedures available at more runways at more airports by significantly reducing the siting problems and frequency congestion associated with ILS.

The Center-TRACON Automation System will complement the above systems by aiding the controller in merging traffic as it flows into the terminal area. It will also provide enhanced throughput and avoid undesirable bunching and gaps in the traffic flow on the final approach path. This system and the Converging Runway Display Aid have been combined into the Terminal ATC Automation program. Finally, the Traffic Alert and Collision Avoidance System has the potential to expand beyond its current role of providing airborne collision avoidance as an independent system. It has the potential to reduce aircraft spacing in a variety of situations, leading to increased capacity.

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4.1.1 Airport Surface Traffic Automation Programs

The runway/approach path safety system that will be provided by Airport Surface Traffic Automation (ASTA) programs will include an automated surveillance capability that provides tower controllers with real-time data on the location and movement of all aircraft and vehicles on the airport surface and the final approach path. This capability will eventually provide an integrated display of the runway/approach path situation, that is designed to prevent conflict situations from developing. It will provide for an automatic detection and presentation to controllers of warning and conflict situations and direct automatic communications with the cockpit for ATC clearances, the airport traffic situation, and automatic emergency conflict resolutions messages. This will provide an all-weather, automated capability that allows for safe, high-capacity operations under all conditions.

Airport Surface Traffic Automation programs will provide tower controllers with real-time data on the location and movement of all aircraft and vehicles, automatic detection and presentation to controllers of warning and conflict situations, and direct automatic communications with the cockpit for ATC clearances.

A major portion of these safety benefits can be achieved by the Airport Movement Area Safety System (AMASS), an early runway incursion protection capability. AMASS will add an automation enhancement to the Airport Surface Detection Equipment-3 (ASDE-3) to provide conflict alert algorithms for tower controllers to detect runway incursions. The AMASS would be used by local and ground controllers at the 29 ASDE-3 sites. The system also includes a track data interface with the Automated Radar Terminal System IIIA (ARTS IIIA) to include airborne aircraft on final approach in the conflict alert algorithms.

Airport Movement Area Safety System, an early runway incursion protection capability, would be used at the 29 ASDE-3 sites.

The ASTA system to control and manage airport surface taxi traffic will incorporate the same basic airport surface surveillance system as described above. This system will provide automated tools to monitor and control airport surface traffic taxi flow (in-trail separation, separation at intersections, monitor one-way traffic flow, issue taxi clearance with route and runway assignment, sequence departure queues, etc.). It will also provide automatic aircraft status information for departure sequencing purposes. This system will permit all-weather operations that will reduce ground controller workload while allowing the controller to continue to take advantage of visual observations.

ASTA will also use a data link system that will permit direct digital data communications with pilots and aircraft flight management computers. Services provided by ASTA include delivery of airport traffic situation information to pilots, delivery of aircraft location in relation to an airport map showing runways, taxiways, etc., and, eventually, delivery of detailed guidance to cockpits to guide aircraft on taxiways to their destination. Additionally, a tower workstation will provide automation support for a number of services to aircraft flight crews. Controllers will review and release pre-departure flight plan clearance data and updates for digital delivery to aircraft in the gate area. Automated Terminal Information Service (ATIS) messages, which provide airport status and weather information, will be created for both voice broadcast and digital delivery to aircraft on the airport surface via the ASTA, and to aircraft in flight via Mode S Data Link. Wind shear alerts will be processed by the tower workstation for digital delivery via Mode S Data Link to aircraft approaching the airport.

4.1.2 Terminal ATC Automation (TATCA)

The purpose of the Terminal ATC Automation program (TATCA) is to assist air traffic controllers and supervisors in enhancing the terminal area air traffic management process and to facilitate the early implementation of these aids at busy airports. The TATCA program consists of two projects: the Converging Runway Display Aid (CRDA) and the Center-TRACON Automation System (CTAS). Longer term TATCA activities include the integration of terminal automation techniques with other air traffic control and cockpit automation capabilities.

4.1.2.1 Converging Runway Display Aid

The CRDA uses automation to display an aircraft at its actual location and simultaneously display its image at another location on the controller's scope to assist the controller in assessing the relative position of aircraft that are on different approach paths. The CRDA is compatible with the ARTS system.

Simulations have shown that this aid may be effective in increasing capacity by allowing multiple runways to be used simultaneously in IFR weather. At St. Louis, the FAA is currently conducting an evaluation of this automation aid to facilitate dependent precision converging approaches to Category I minima, approaches which currently can only be used to high IFR ceilings. (This is discussed further in Section 3.1.5.1.)

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4.1.2.2 Center-TRACON Automation System

The approach to major terminal areas represents one of the most complex and high-density environments for air traffic control. Arrivals approach from as many as eight directions, with jet arrivals descending from high altitudes while other traffic enters from low altitudes. It is difficult for controllers to foresee how traffic from one approach path will ultimately interact with traffic from other approach paths. This results in traffic arriving either in bunches or with significant gaps, which in turn reduce airport capacity. Speed and space restrictions in the terminal area add to the difficulty of maintaining an orderly flow to the runway. Visibility and wind shifts, variations in aircraft mix, wake vortex considerations, missed approaches, runway/route changes or closings, all add to the difficulty of controlling traffic efficiently and safely in the terminal airspace.

The CTAS is designed to improve system capacity by helping the controller smooth out the traffic flow and eliminate gaps in arrivals. The earliest CTAS products are a Final Approach Spacing Tool (FAST) for the TRACON and a Traffic Management Advisor (TMA) for the ARTCC. The TMA will help en route controllers to coordinate aircraft crossings at arrival fixes so that they can be efficiently merged into the final approach stream by the TRACON controller. The FAST will aid the TRACON controllers in merging arrival traffic into an efficient flow to the final approach path. It will also allow the controller to efficiently merge missed approach and pop-up traffic into the final approach stream. Longer-term CTAS activities focus on integration of terminal automation with other ATC automation and cockpit automation activities.

CTAS is designed to improve system capacity by helping the controller smooth out the traffic flow and eliminate gaps in arrivals.

4.1.3. Precision Runway Monitor (PRM)

Significant capacity gains can be achieved at airports with closely spaced parallel runways if the allowable runway spacing for conducting independent parallel instrument approaches can be reduced. (The benefits associated with reduced spacings are discussed in Section 3.1.3.1.) Current criteria allow independent approaches to parallel runways separated by 4,300 feet or more. This standard was established based on the surveillance rate and accuracy of the airport surveillance radars (ASRs) and the terminal Automated Radar Terminal System (ARTS) capabilities. Analysis and demonstrations have indicated that the separation between parallel runways could be reduced if the surveillance data rate and the radar and display accuracy were improved. Conventional airport surveillance radars update the target position every 4.8 seconds.

The FAA has fielded engineering models of two types of PRM systems to investigate the reduction in separation associated with these improvements. The PRMs consist of improved antenna systems that provide high azimuth and range accuracy and higher data rates than the current terminal ASR radars, a processing system that monitors all approaches and generates controller alerts when an aircraft appears to be entering the no transgression zone between the runways, and a high resolution display system. One version utilizes an electronically scanned antenna that is capable of updating aircraft positions every half second and the other utilizes two mechanically rotating antennas mounted back-to-back that together update aircraft positions every 2.4 seconds.

The PRMs consist of improved antenna systems that provide high azimuth and range accuracy and higher data rates, a processing system that monitors all approaches and generates controller alerts, and a high resolution display system.

Demonstrations have shown that either version of the PRM can allow independent parallel operations for runways as close as 3,400 feet apart. Further research and development, including ATC simulations at the FAA Technical Center, are planned to determine the requirements for conducting independent parallel approaches to runways as close as 2,500 feet apart.

4.1.4 Microwave Landing System (MLS)

Subsequent to the year 2000, the United States intends to completely transition from the Instrument Landing System (ILS) to the MLS. This transition is in accordance with international plans to transition to MLS as the standard precision instrument approach system. By January 1998, all international runways in the U.S. will be equipped with MLS capability.

The ILS has provided dependable precision approach service for many years. However, inherent characteristics of the ILS have caused difficulties in congested terminal areas. Of particular concern from an air traffic perspective is the long straight-in flight path required by ILS. This restriction is not a major concern for isolated airports without obstruction problems, but, for closely spaced airports, ILS finals often create conflicts because flight paths may cross in ways that preclude separation by altitude. In these configurations the airports become interdependent (i.e., preferred operations cannot be conducted simultaneously at the affected airports), causing delays and constraining capacity. In areas such as New York, the curved approach capability provided by MLS will provide a solution to the interdependency of proximate airports.

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The MLS will also enable the FAA to provide precision approach capability for runways at which an ILS could not be utilized due to ILS localizer frequency-band congestion or FM radio transmitter interference. For example, it is already difficult to add ILS facilities in congested areas such as Chicago and New York. The MLS has two hundred operational channels, with additional channels available for future growth and development. In addition, there are no nearby frequencies in use to create interference.

It may also be possible to achieve lower minima with MLS than can be achieved with ILS at some sites. Moreover, MLS will relieve surface congestion resulting from restrictions caused by ILS critical area sensitivity to reflecting surfaces such as taxiing and departing aircraft.

Use of MLS back azimuth for missed approach guidance may help support development of approach procedures for converging runway and triple runway configurations. Use of back azimuth for departure guidance will help ease airspace limitations and restrictions on aircraft operations due to noise abatement requirements.

MLS provides for more flexible ground siting of equipment to compensate for terrain irregularities that do not permit a centerline siting. These irregularities include, but are not limited to, mountains, rivers, and valleys. Additionally, MLS does not require as extensive a site preparation as ILS, since MLS does not form guidance signals through ground reflection.

The MLS/RNAV capability with wide-area coverage will provide more flexibility in the terminal airspace. It will permit the design of instrument approach procedures that more closely approximate traffic patterns used during VMC. Typically these result in shorter flight paths, segregation of aircraft by type, reduction of arrival and departure gaps, and avoidance of noise sensitive areas.

MLS/RNAV will provide the capability of computing a centerline approach to secondary runways, both parallel and intersecting, that lie within the coverage volume of the instrumented runway. MLS/RNAV will also allow computing a centerline approach to a primary runway where ground terrain has caused the azimuth station to be offset a considerable distance from the runway centerline.

MLS will relieve surface congestion resulting from restrictions caused by ILS sensitivity to reflecting surfaces such as taxiing and departing aircraft.

The MLS/RNAV capability will permit the design of instrument approach procedures that more closely approximate traffic patterns used during VMC.

4.1.5 Traffic Alert and Collision Avoidance System (TCAS) Applications

TCAS is an airborne system that operates independently of ground-based ATC to provide the pilot with advisories concerning nearby transponder-equipped aircraft. The TCAS II system mandated for use in transport category aircraft provides relative position information and, when necessary, advisories for vertical maneuvers to avoid collisions. This system is expected to be fully implemented on transport carrier aircraft by the end of 1993. Because of the information provided by TCAS and its widespread equipage, it has been identified as having the potential to increase ATC capacity and efficiency and reduce controller workload.

A program is being established to investigate use of TCAS to support reduced spacing on final approach, reduce the stagger requirement for dependent converging approaches using the CRDA, allow departures at reduced spacing, and monitor separation between aircraft on independent approaches. Should these applications prove successful, additional development will be pursued in the areas of wake vortex avoidance, TCAS-based parallel approach monitoring, TCAS-based self-spacing, and other more advanced applications.

The Traffic Alert and Collision Avoidance System is an airborne system that provides the pilot with advisories concerning nearby transponder-equipped aircraft.

A program is being established to investigate use of TCAS to reduce spacings and increase capacity.

4.2 En Route Airspace Capacity Technology

En route airspace congestion is being increasingly identified as a factor in restricting the flow of traffic at certain airports. In 1990, 38 percent of all delays were attributed to limitations in terminal and en route airspace. One cause of en route airspace congestion is that ATC system users want to travel directly from one airport to another at the best altitude for their aircraft, and hundreds of aircraft have similar performance characteristics. Therefore, some portions of airspace are in very high demand, while others are used very little. This non-uniform demand for airspace translates into the need to devise equitable en route airspace management strategies for distributing the traffic when demand exceeds capacity.

Initiatives designed to reduce delays, match traffic flow to demand, and increase users' freedom to fly user-preferred routes are underway. These initiatives have a large technology component as well as significant procedural impacts.

Automated En Route Air Traffic Control (AERA) is a long-term evolutionary program that will increasingly allow aircraft to fly their preferred routes safely with a minimum of air traffic control intervention. The Advanced Traffic Management System (ATMS) will allow air traffic managers to identify in advance when en route

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or terminal weather or other factors require intervention to expedite and control the flow of traffic.

The increasingly crowded oceanic airspace is also being addressed. Initiatives that improve the control of this airspace, particularly the more accurate and frequent position reporting resulting from Automatic Dependent Surveillance (ADS) using satellite technology, will make it possible to effect significant reductions in oceanic en route spacing.

Other means of improving en route airspace capacity include reducing the vertical separation requirements at altitudes above FL290 to allow more turbojet aircraft to operate along a given route near their preferred altitudes and reducing the minimum in-trail spacing to increase the flow rate on airways.

4.2.1 Advanced Traffic Management System (ATMS)

The purpose of the ATMS is to minimize the effects of NAS overload on user preferences without compromising safety. This is accomplished by:

- Monitoring the demand on and capacity of ATC resources,
- Developing alternative strategies to balance demand and capacity to prevent critical entities from being overloaded,
- Coordinating and implementing strategies to assure maximum use of critical resources when a demand/capacity imbalance is predicted or detected.

The Traffic Management System will minimize NAS overload effects on user preferences without compromising safety. The capabilities of the TMS consist of the Aircraft Situation Display, Monitor Alert, Automated Demand Resolution, Strategy Evaluation, and Directive Distribution.

The Aircraft Situation Display (ASD) was the first capability developed by ATMS. The ASD generates a graphics display that shows current traffic and flight plans for the entire NAS. The ASD is currently deployed at the Air Traffic Control System Command Center (ATCSCC), all ARTCCs, and selected TRACONs.

The ASD has helped increase system capacity in several ways. It allows Traffic Management specialists to observe approaching traffic across ARTCC boundaries. This has allowed the reduction or elimination of many fixed miles-in-trail restrictions (and the resultant delay of aircraft) that were in effect prior to the deployment of ASD. It allows Traffic Management Specialists to detect and effect solutions to certain congestion problems, such as merging traffic flows, well in advance of problem occurrence and even before the aircraft enter the ARTCC where the congestion problem will occur. Small adjustments to traffic flows made early can avoid large delays associated with last minute solutions.

The ASD also assists Traffic Management specialists in planning arrival flows, especially for airports that are close to ARTCC boundaries. Smoother arrival flows result in better airport utilization.

The second capability developed by ATMS was the Monitor Alert which attempts to predict traffic activity several hours in advance. It compares the predicted traffic level to the threshold alert level for air traffic control sectors, fixes, and airports, and highlights predicted problems. It will aid in detecting congestion problems further in advance, enabling solutions to be implemented earlier. The Monitor Alert has recently been implemented at the ATCSCC, all ARTCCs and several TRACONs.

Three future capabilities that are being developed through ATMS are Automated Demand Resolution, Strategy Evaluation, and Directive Distribution. Automated Demand Resolution will examine problems predicted by Monitor Alert and suggest several alternative problem resolutions. The suggested resolutions are planned to respond to each problem without creating conflicts or additional problems. Strategy Evaluation will provide a tool for the specialist to compare the suggested resolutions. Directive Distribution will automatically distribute the necessary flow directives to implement the selected resolution.

4.2.2 Automated En Route Air Traffic Control (AERA)

AERA is a collection of automation capabilities that will support ATC personnel in the detection and resolution of problems along an aircraft's flight path, and in the planning of traffic flows. AERA will help increase airspace capacity by improving the ATC system's ability to manage more densely populated airspace. AERA will also improve the ability of the ATC system to accommodate user preferences. When the most desirable routes are unavailable because of congestion or weather conditions, AERA will assist the controller in finding the open route closest to the preferred one.

> Automated En Route Traffic Control will help increase airspace capacity by improving the ATC system's ability to manage more densely populated airspace.

The most highly automated phase of the AERA program is the aircraft separation assurance function and local flow management function. The ATC specialist becomes a manager of traffic flows, planning and selecting strategies rather than directing the flight paths of individual aircraft. This phase of AERA takes advantage of advanced systems such as flight management systems and data link.

Laboratory facilities for the AERA program were established in 1987. This laboratory has been used for prototyping and analyses of systems and concepts to develop operational and specification requirements, as well as associated supporting technical documentation. These algorithmic and performance specifications and candidate ATC procedures will be completed in 1991.

In the next phase of the AERA program, software will be developed and undergo an operational evaluation at the FAA Technical Center. The AERA software and the ATC procedures will be updated as a result of the operational evaluation. This operational evaluation phase has already begun, and is scheduled to continue through 1997.

In 1989, the AERA program accomplished the first build of a prototype ARTCC in an AERA environment, called the AERA Protocenter, which simulates an integrated automation of the separation and planning functions. The Protocenter has successfully separated aircraft in realistic simulation scenarios consisting of over 100 aircraft. In 1990, the Protocenter was enhanced to include a metering function, so that it will not only keep aircraft separated, but will also develop time schedules and generate clearances to ensure that aircraft meet assigned time constraints, such as metering into terminal areas. Another recent enhancement to the Protocenter is a set of functions to cope with data uncertainties resulting from imperfect knowledge of winds aloft or aircraft speeds. The aggregate of recent enhancements resulted in Build 2 of the Protocenter, capable of successfully separating and metering aircraft in realistic simulation scenarios consisting of over 500 aircraft. In addition to the Protocenter, the AERA program is investigating the human role in a highly automated ATC environment, using a team of controllers, pilots, and specialists in traffic management and meteorology.

4.2.3 Automatic Dependent Surveillance (ADS) and Oceanic ATC

In the ADS system the information generated by an aircraft's onboard navigation system is automatically relayed from the aircraft, via a satellite data link, to air traffic control facilities. The automatic position reports will be displayed to the air traffic controller in nearly real time. This concept will revolutionize ATC in the large oceanic areas that are beyond the range of radar coverage. Currently oceanic air traffic control depends upon hourly reports transmitted via High Frequency (HF) voice radio, which is subject to interference. There is no separate surveillance channel. Oceanic ATC is largely manual and procedural and operates with very little and often delayed information. Because of the uncertainty and infrequency of the position reports, large separations are maintained to assure safety. These large separations effectively restrict available airspace, and cause aircraft to operate on less than optimal routes.

In the ADS system the information generated by an aircraft's onboard navigation system is automatically relayed via a satellite data link to air traffic control facilities. It will be part of an Oceanic ATC System to support flights over the Pacific and Atlantic airspace.

ADS will be a part of an Oceanic ATC System to support transoceanic flights over millions of square miles of Pacific and Atlantic airspace. This Oceanic ATC system will provide an automation infrastructure including oceanic flight data processing, a computer-generated situation display, and a strategic conflict probe for alerting controllers to potential conflicts hours before they would occur. The first phase of the new system, the Oceanic Display and Planning System (ODAPS), became operational in the Oakland Air Route Traffic Control Center (ARTCC) in December 1989 and is scheduled to become operational in the New York ARTCC in 1993. In 1993, real-time position reporting via ADS and a limited set of direct pilot-controller data link messages will be added to the system, and, in 1995, a fully robust satellite data link will be operational.

The new Oceanic ATC System will provide benefits to airspace users in several areas — safety, efficiency, and capacity. The improved position reporting will allow better use of the existing separation standards. Air traffic management can begin the process of reducing those standards, thereby increasing the manageable number of aircraft per route. The strategic conflict probe will allow controllers to evaluate traffic situations hours into the future. Ultimately, controllers will be able to grant more fuel-efficient direct routes. These improvements in efficiency and capacity will have a dramatic impact on fuel costs and delays.

4.3 System Planning, Integration, and Control Technology

The following sections describe technologies that support planning for improvements in the NAS. Both operational improvements and new technologies can be evaluated so that they can be developed and implemented effectively. The National Simulation Laboratory (NSL) will provide the overall framework assuring the integration and interoperability of the elements of the NAS. A large number of models and other technologies will support this integration effort. The National Airspace System Performance Analysis Capability (NASPAC), for example, will help in the identification of demand/capacity imbalances in the NAS, and provide a basis for evaluation of proposed solutions to such imbalances. Computer-graphics tools, such as the Sector Design Analysis Tool and the Terminal Airspace Visualization Tool, will allow airspace designers to quickly and effectively develop alternative airspace sectors and procedures. They will also reduce the time and effort required to implement these alternatives.

Finally, the National Control Facility (NCF) will provide the means to analyze and manage the NAS on an ongoing basis, as well as provide effective training for the requisite personnel.

4.3.1 National Simulation Laboratory

The NSL will be dedicated to assessing the integration and interoperability of elements of the evolving NAS early in the system development process. These assessments will include both pilot and controller human factors considerations. The NSL will be used for interoperability assessments of prototype versions of emerging systems, with an emphasis on the early identification and resolution of cross-system operational and capacity issues. The results of these assessments will be better planning for NAS development and more accurate and achievable system specifications.

The NSL will also provide a means for analyzing and experimenting with alternative concepts for NAS development. It will have the capability to develop prototype alternative NAS configurations at the system design level, so that promising new technologies and concepts can be evaluated and compared at an early stage in their development.

The initial effort has been to establish the Integration and Interaction Laboratory (I-Lab) as a proof-of-concept demonstration. The NSL will begin operation in FY93 by porting I-Lab simulations and prototypes to the more capable processors expected to be available at that time. I-Lab experimentation will continue in parallel.

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The Integration and Interaction Laboratory (I-Lab) has been established, initially, as a proof-of-concept demonstration.

4.3.2 Analysis Tools

A large and growing repertoire of analytical, simulation, and graphical tools and models are being developed and used to help understand and improve the NAS. Some of the more prominent of these are briefly described in the following sections.

4.3.2.1 Computer Simulation Models

The principal objectives of computer simulation models currently in use and under development are to identify current and future problems in the NAS caused by demand/capacity imbalances and to construct and evaluate potential solutions. All of the models rely on a substantial amount of operational data to produce accurate results. The principal models that are being developed and are in use today are described below.

The National Airspace System Performance Analysis Capability (NASPAC) is a simulation of the entire NAS, including detailed modeling of 58 key airports and en route sectors and airspace. It models individual aircraft throughout their daily itineraries, so that it is sensitive to the ripple effects of congestion and delays. It has been used to evaluate significant changes to the airspace system such as new airports, runway closures, and flow control restrictions. A simplified, user-friendly desktop version of the NASPAC that requires only minimal training and preparation will be developed, and the models will be enhanced, as required, for specific FAA applications regarding system performance.

The Airport Network Simulation Model (AIRNET) is a PC-based tool that is designed to assess the impact of changes in airport facilities, operations, and demand. It is a planning tool that can assess the effects of those changes on passenger costs, noise contours, airports, airlines, and aircraft. It addresses macro trends and interactions for use in policy planning and economic analysis.

The Airport and Airspace Simulation Model (SIMMOD) simulates both airports and airspace in a selected geographic area. It aids in the study of en route air traffic, terminal air traffic, and ground operations. It is capable of calculating capacity and delay impacts of a variety of operating alternatives, including runway configurations, airspace routes, sectorization, and separation standards. It is a planning tool for evaluating operational alternatives involving the coordination of airport configurations with airspace configurations. SIMMOD has been used in a number of airspace design studies around major airports. Improvements to SIMMOD include better output displays, automated data-acquisition capability, and a workstation version of the model.

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AIRNET is a PC-based tool designed to assess the impact of changes in airport facilities, operations, and demand.

SIMMOD simulates both airports and airspace in a selected geographic area and is capable of calculating capacity and delay impacts of a variety of operating alternatives.

The Aircraft Delay Simulation Model (ADSIM) calculates travel time, delay, and flow rate data to analyze components of an airport, airport operations, and operations in the adjacent airspace. It traces the movement of individual aircraft through gates, taxiways, and runways. The Runway Delay Simulation Model (RDSIM) is a sub-model of ADSIM. RDSIM limits its scope to the final approach, runway, and runway exit.

ADSIM calculates travel time, delay, and flow rate data to analyze components of an airport, airport operations, and operations in the adjacent airspace.

RDSIM is a sub-model of ADSIM that limits its scope to the final approach, runway, and runway exit.

SDAT is an automated tool to be used by airspace designers at the 20 ARTCCs to evaluate proposed changes in the design of airspace sectors, allowing the user to input either the current design or the proposed replacement.

4.3.2.2 Sector Design Analysis Tool (SDAT)

The SDAT is an automated tool to be used by airspace designers at the 20 Air Route Traffic Control Centers (ARTCCs) to evaluate proposed changes in the design of airspace sectors. This computer model will allow the user to input either the current design or the proposed replacement. It will also allow the user to interactively make changes to the design shown graphically on the computer screen.

The model will allow the user to play recorded traffic data against either the actual design or the proposed replacement. It will also allow the user to modify traffic data interactively in order to evaluate alternative designs under postulated future traffic loadings. The model will compute measures of workload for the specified sector or group of sectors. This will allow designers to obtain a better balance in workload between sectors, reducing delays and staffing requirements. The model will also be useful for facility traffic flow managers, for it will display cumulative traffic flows under either historic or anticipated future traffic loadings.

The development of the SDAT has been underway for approximately two years. Procedures for extracting the requisite data from FAA data files and computing the expected demand for separation assurance actions have been developed. A preliminary two-dimensional prototype model has been developed. This model concentrates on only one element of controller workload, the critical element of maintaining safe separation between aircraft.

4.3.2.3 Terminal Airspace Visualization Tool (TVAT)

Terminal airspace differs from en route airspace due to a more varied mix of aircraft and user types, more complicated air traffic rules and procedures, and wider variation in flight paths. A major redesign of terminal airspace currently requires extensive coordination and the effort of a task force lasting many months or even years. The purpose of the TAVT is to provide computer-based assistance to such a task force that will allow the rapid evaluation of many alternatives, e.g., development of new terminal airspace procedures. An effort is currently underway to develop a prototype to model and support the evaluation of terminal airspace.

The purpose of the TAVT is to provide computer-based assistance to airspace planners evaluating the redesign of terminal airspace.

The modeling effort has three goals. First, to display a three-dimensional representation of the airspace on a large computer screen to allow the user/operator to view the airspace from any perspective. The second goal is to provide an easy-to-use interface that permits the user to modify the airspace according to permissible alternatives. The final goal is to develop the capability to quickly evaluate the airspace as displayed to the user in terms of capacity and any other appropriate criteria. A prototype version of the 3-D display is under development at this time on an advanced graphics workstation. The first goal of visualizing a complex terminal airspace has been demonstrated using the proposed Dallas-Fort Worth Metroplex terminal airspace. Development of an interactive, on-screen editing capability is currently underway.

4.3.3 National Control Facility (NCF)

The proposed NCF is intended to provide three major functions to support the goals of the FAA:

The NCF is intended to provide traffic management functions, modeling, and analysis to provide the FAA with tactical recommendations and forecasts, and management development to familiarize users with the capabilities of the air traffic control system.

- The traffic management function, currently the Air Traffic Control System Command Center (ATCSCC), will ensure the viability of, and provide the national direction and airspace management of, the air traffic control system.
- The modeling and analysis function will include the data bases, personnel, and systems required to provide FAA and selected organizations with tactical recommendations and forecasts based on computer simulation and optimization models, as well as studies and analyses of the air traffic system.
- The management development function will provide a structure to familiarize users with the capabilities of the air traffic control system. Specific areas to be addressed in the curriculum include orientation to national airspace management, recurring training in system management techniques for FAA airspace managers, operational review and critique, and demonstration to the airspace system users of potential system problems identified through modeling efforts.

This facility will house the airspace management organization, the National Weather Service Central Flow Weather Service Unit (CFWSU), the National Flight Data Center (NFDC), and the National Maintenance Coordination Complex (NMCC). The systems required to support these organizations will also be housed here.

The traffic management element of the NCF will contain the personnel and systems needed to manage the Nation's air traffic system. A proactive management role using a combination of the data currently available, improved processing, better communications, and additional data is envisioned.

The modeling and analysis element of the NCF will provide the capabilities required to perform in-depth statistical and analytical studies of the airspace system. These studies will enable the examination of solutions to airspace problems and the determination of the maximum utilization of the airspace system on a real-time basis as well as during a long-term planning effort. It will also provide simulations and reconstructions to support the training and refresher activities of the Management Development Facility. The functions required to support this effort include database management, airspace and rules simulations, and system analysis.

To support the modeling element, current capabilities such as NASPAC, AIRNET, and SIMMOD will be enhanced and used to support operational planning as well as the longer-term analysis capabilities they currently provide to support system planning of the NAS. In order to support airspace planners that will use the NCF modeling capabilities, computer-based airspace design tools will be developed. These tools will be designed to address a range of airspace design problems from relatively localized problems affecting a single sector or terminal area to regional or national scale problems.

4.3.4 Traffic Flow Planning

Increasing congestion, delays, and fuel costs require that the FAA take immediate steps to improve airspace use, decrease flight times and controller work loads, and increase fuel efficiency. To achieve these objectives the FAA Traffic Flow Planning program will develop near-term, operational traffic planning models and tools. The program will provide software tools to plan daily air traffic flow, predict traffic problems and probable delay locations, assist in joint FAA-user planning and decision-making, and generate routes and corresponding traffic flow strategies which minimize fuel and time for scheduled air traffic. Benefits include improved aviation safety, airspace use, system throughput, and route flexibility.

Working directly with commercial aviation interests and other FAA facilities, the Air Traffic Control System Command Center (ATCSCC) can predict problem areas before they occur and generate alternative reroutings and flow procedures. Overall system capacity will be increased over that of the present fixed route and rigid preferred route systems, and increased fuel efficiency, shorter travel times, and reduced delays will result. Controller workloads will decrease from users' participation in a planned, systematic flow of traffic.